2018 Year In Review

Contents

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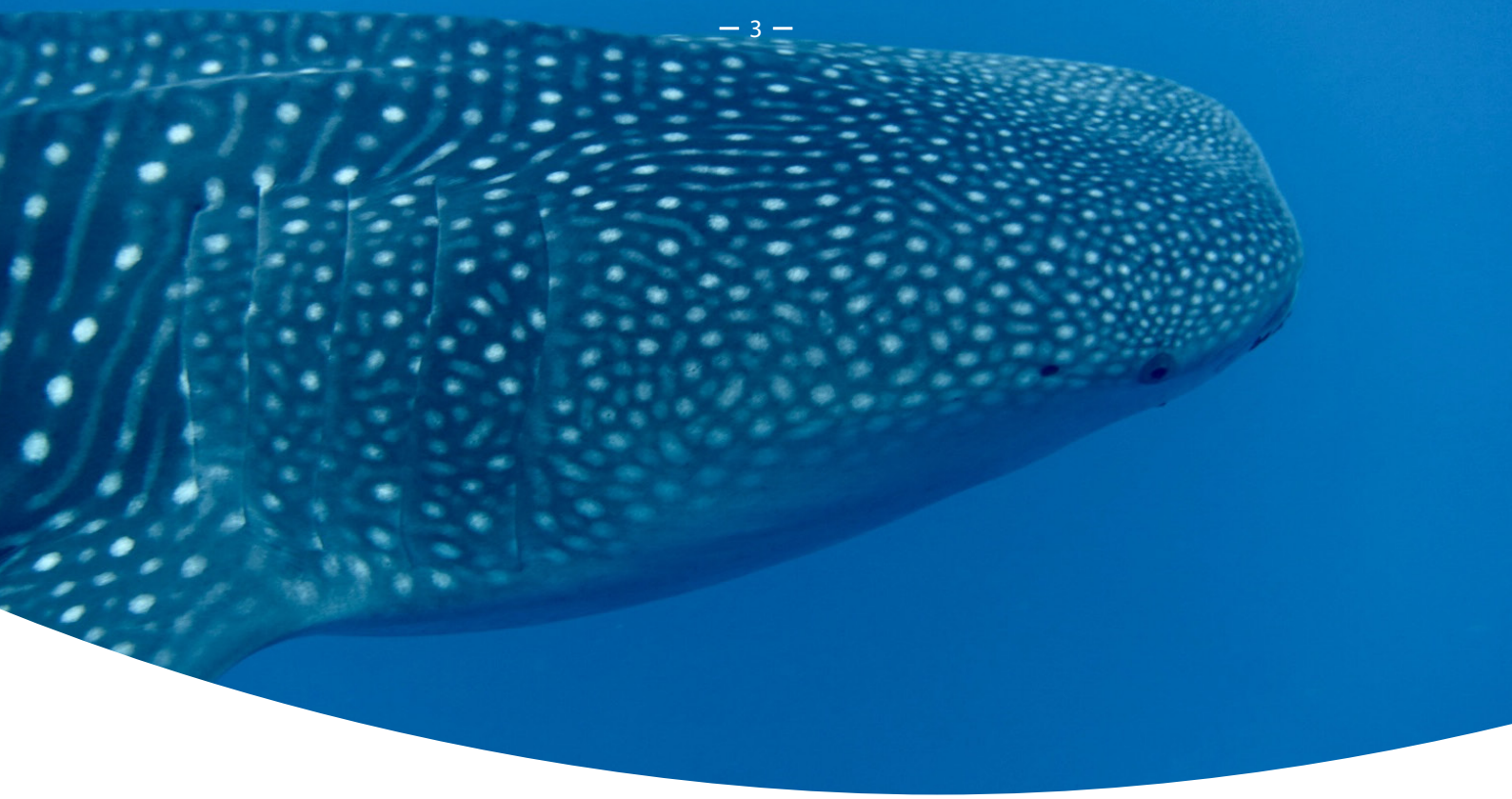
Photos by Alex Childs, Ellie Waiwright, Jil Kuhne, Gregor Kervina, MWSRP staff



Overview

Mission Statement

The charity's objectives are to promote for the benefit of the public the conservation, protection and improvement of the physical and natural environment of whale shark and marine biological diversity by: (a) promoting and carrying out for the public benefit research and publishing or otherwise disseminating the useful results of such research: (b) raising awareness and understanding of marine conservation.

Background

The whale shark Rhincodon typus is the largest species of fish on Earth, attaining lengths in excess of 12m. Nonetheless, very little is known about its distribution, habitat requirements, movements or reproduction – all of key importance for conserving and managing this marine mega-vertebrate. The Maldives appears to be unusual, perhaps unique in the Indian Ocean, in supporting a year round aggregation of whale sharks, making the archipelago a superb place to study their behaviour and biology.

Despite these opportunities for research, there were virtually no scientific studies of whale sharks in the Maldives before the MWSRP engaged in a three-month research expedition in 2006. That pilot study documented several dozen sharks and also highlighted the need for further research, conservation and education and provided the seed for the creation of the MWSRP.

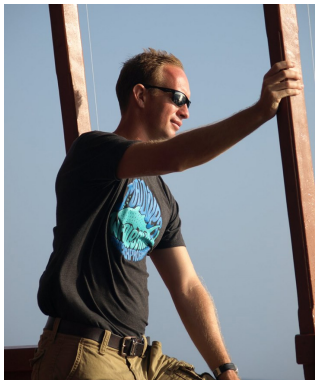
The MWSRP has accumulated over 6600 photographic sightings of 391 individual sharks dating back to 1996. Over the years a more complete, and increasingly puzzling picture has begun to emerge of whale shark demographics and spatial usage in the Maldives. Early assumptions of whale shark aggregations 'in the Maldives' being juvenile male sharks in the 4-7m range has transpired to mean only in certain aggregation sites. Neonate sharks, assumedly pregnant females over 12m long and sizes just over and under these extremes are beginning to appear in the Big Fish Network records with increasing frequency. The future understanding of the wider demographics is a key part of MWSRP's plans, with survey trips and technology now in place to begin exploring this exciting new ground.

The MWSRP's research in to the characteristics and movements of the whale shark population in the Maldives provides the scientific basis behind the Programme's role as a grassroots conservation charity. Since 2006 the MWSRP has made numerous school visits, conducted education field trips and facilitated international cultural exchange programmes for local children. Industry stakeholders, fisherman and local-island governing agencies have also been continuously consulted and the Programme has been successful in fostering cooperation between resort and island communities and re-establishing an important bond between the local community and the whale shark.

The MWSRP has continued to provide key information to the various ministries of the Maldivian government. Two notable achievements to date include the government's adoption of whale shark encounter guidelines for tour operators developed by the MWSRP in stakeholder consultations and more recently in 2009 the gazetting of the Maldives largest collaboratively managed Marine Protected Area (MPA).

The South Ari Atoll Marine Protected Area (MPA) encompasses the Maldives primary whale shark aggregation site and by forging partnerships with resorts and local communities, the MWSRP is continuing to assist the government by building the management capacity of the local stakeholder and island communities within the MPA.

A year in summary



Jim's Key Stats

Jim love's his stats and here our Operations Director breaks down 2018 in numbers.

A note on Jim, we're very sad to announce that this is his last annual report, as he's moving on to pastures new. Jim Co-founded the MWSRP back in 2006 and has steered the programme to where it is today. We can not begin to thank you enough Jim for the enormous sacrifices you've made over the years. The MWSRP simply wouldn't be here without you.

Thank you Jim

- Total number of submitted encounters – 541
- Of which MWSRP – 175
- Of which BFN – 366 (thank you!)

- 85 different positively identified sharks in total
- 438 of these encounters were with 48 individuals already known to MWSRP prior to 1st Feb 2018

- There were 37 new whale sharks added to the BFN database between Feb 1st 2018 and Feb 1st 2019
- Most frequently seen individual;
- 1) WS337 on 60 occasions
- 2) WS221 on 26 occasions
- 3) WS262 on 25 occasions

- It's been a big year for female whale sharks!
- 14 of the 37 new sharks to the BFN database in 2018 were confirmed as female, more than confirmed males – that's a first!
- A total of 19 submissions of 16 different individuals were confirmed female this year
- Every submission to the BFN south of Huvadhoo Kandu in 2018 was a female shark
- Males are still the most seen however! 400 submissions of 53 positively identified individuals (and 3 encounters where ID was unknown) were confirmed as male

- Average estimated length from all 406 submitted estimations (BFN & MWSRP) was 5.56m
- Average length new sharks on the database is just 4.52m. This tides in with MWSRP's earlier findings that new recruits recorded for the first time are generally smaller than sharks that have shown a year or more of residency
- The new female sharks come mostly from the southern atolls and tend to be slightly smaller, or much bigger! At the smaller end of the spectrum, new female sharks average length was just 3.47m. Then there is a gap and the average of the larger end of the spectrum female sharks is 10.75m
- New male sharks averaged 4.88m, but from a much smaller range of 3.8m to 6.5m

- Average encounter duration in South Ari MPA was 9.7 minutes per shark
- Shark behaviour is shown to be a proxy for encounter duration. Sharks showing evasive behaviour have the shortest encounter durations (4.64 minutes), while those showing inquisitiveness being the longest encounters (22.93 mins), with cruising and feeding sharks in between

- Top 3 atolls for encounters by submitted number;
- South Ari with 464 encounters
- Thaa with 31
- Baa with 25

Achievements and Performance

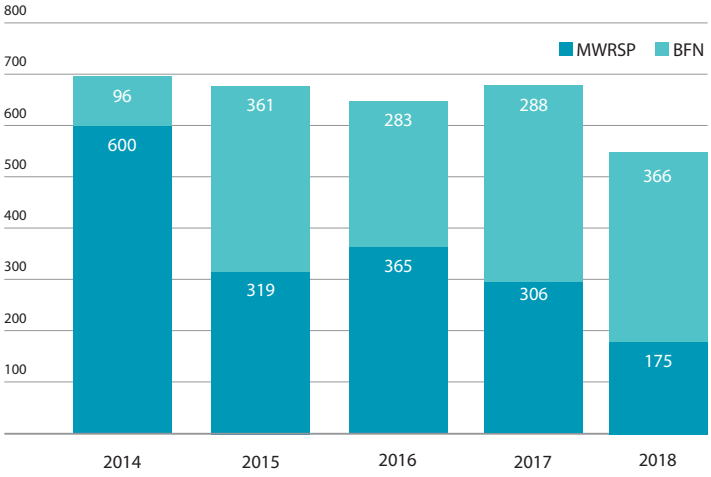
Research Summary

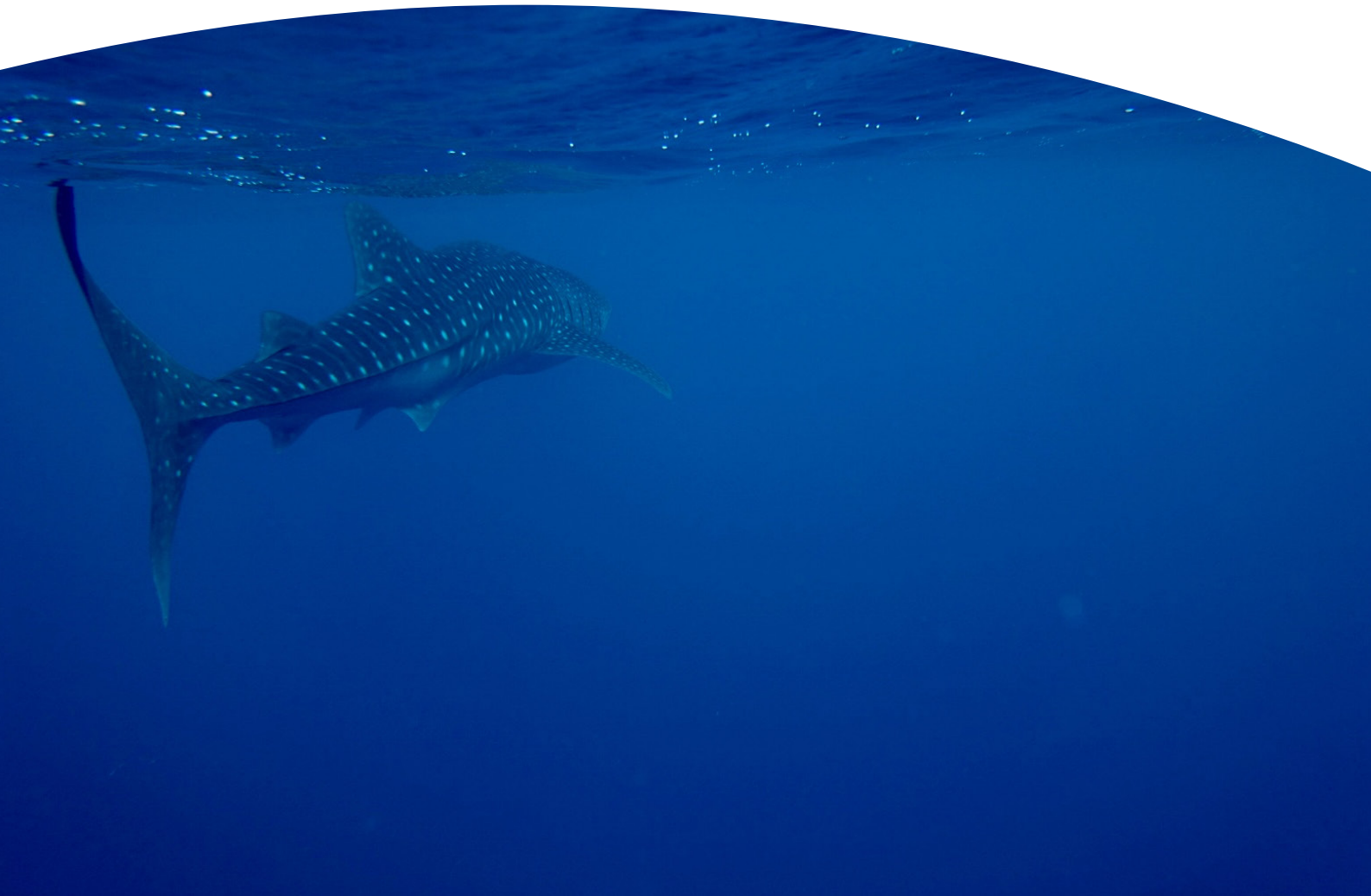
Overall Whale Shark Encounter Log Information

First of all a quick reminder – the information in this section and for the rest of the report offers a snapshot into the past 12 months only, unless otherwise stated. If anyone would like further information on previous seasons or on the holistic understanding of this species in the Maldives or in specific areas, please do reach out to MWSRP!

Between February 2018 and February 2019 there was a total of 541 whale shark encounters recorded to the Big Fish Network in the Maldives. This comprised of 175 encounters recorded by the MWSRP researchers which also included environmental parameters. The remaining 366 encounters were contributed by citizen science stakeholders of the Big Fish Network (BFN), predominantly from active members of the tourism sector.

Total Sightings





445

At the time of writing, the total number of different individual whale sharks recorded from across the Maldives since 2006 now stands at 445.

Of the whale sharks encountered, there were 85 different positively identified individuals, with an additional 38 encounters where identification of the individual was not possible. Of the definitively identified sharks, 48 individuals were previously known and were present on the individual whale shark library prior to the 1st February 2018.

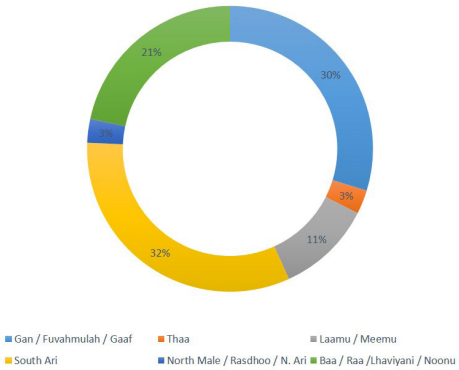
While not quite as prolific as last year's haul of new sharks (48), 2018 netted 37 new individuals to the Maldives individual whale shark database. Once again, this can be contributed to the reach of the BFN into remote parts of the country and in particular Fuvahmulah, a hugely exciting region that will undoubtedly provide more discoveries in years to come. Happily, Baa atoll continued to see a good return of sharks this year with 25 around the famous Hani Faru area while Thaa atoll had a quieter season, seeing 31 encounters, down from 74 in 2017.

The total number of different individual whale sharks recorded on 1st February 2019 from across the Maldives since 2006 now stands at 391. At the time of writing, (May 2019) this now stands at 445.

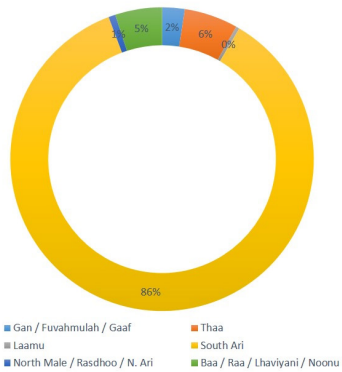
Once again, South Ari remained the main location for newly identified sharks, with 12 of the 37 individuals being seen for the first time here. However, submissions of whale shark encounters from areas outside of SAMPA were considerably more likely to be of a new individual, with an average or 1 new shark for every 3 submitted encounters in the last 12 months from areas outside SAMPA, compared to 1 new shark in every 39 encounters on average from the SAMPA region. As with 2017, the established whale shark sites in the southern and northern atolls were the other major contributors to new sharks on the database, with Baa adding 5, Gaaf 4 and Fuvahmulah 7.

What does this mean in terms of the overall population of whale sharks in the Maldives? Right now, there is no sign that the number of encounters with whale sharks outside of SAMPA that are new to the Maldives BFN database are anywhere close to stabilising. It is also unclear just how open this population is at this time. In short, there are a lot more sharks out there still to be encountered and re-encountered before we can make an informed estimation of the number of individuals that can be expected to be in Maldivian waters at any given time. We do however look forward to following this in years to come and hope to get an answer to this important question!

Locations of Newly Identified WS in 2018



Whale Shark Sightings by Location 2018



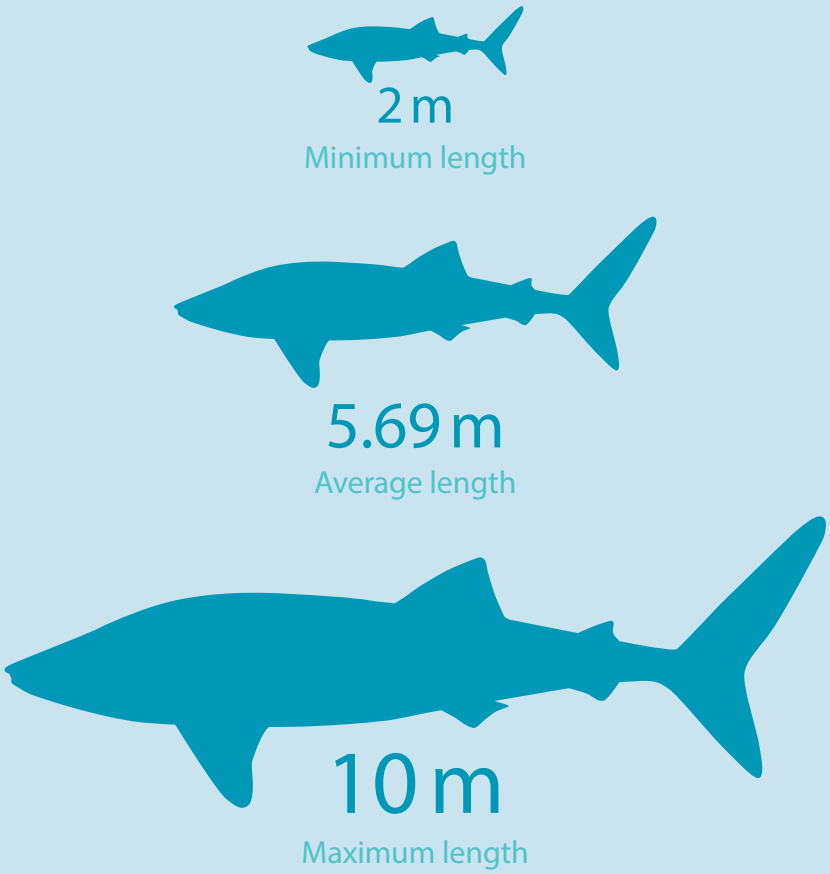
Looking more generally at where encounters were recorded across the Maldives in 2018, MWSRP is again delighted to show a broad spread across most of the country, though this year minus the northernmost atolls.

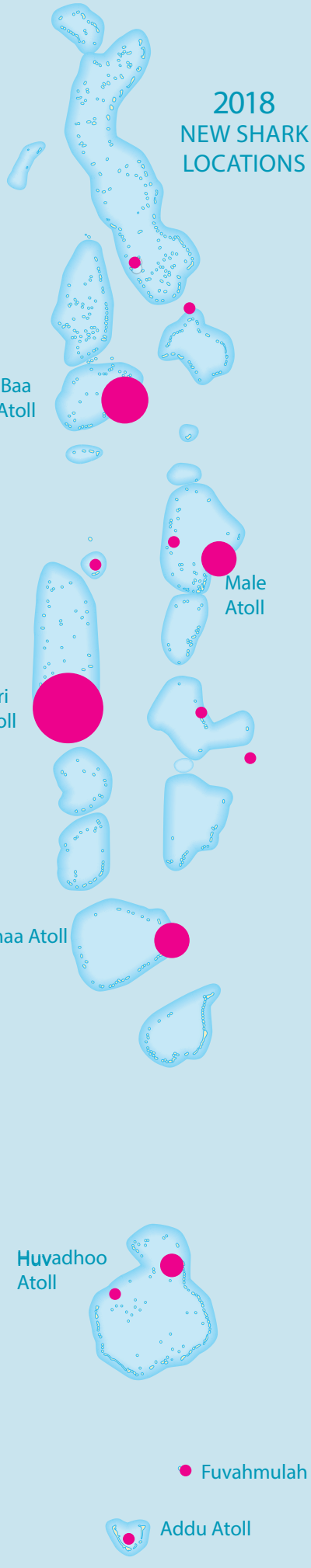
As is expected, South Ari atoll dominates the sightings frequency again, in no small part a result of search effort and number of BFN contributors concentrated in this area; as well as it being a remarkable year round aggregation site of course!

Thaa and Baa atolls continue to be seasonally well represented, with the big new contributor being Fuvahmulah atoll. Fuvahmulah is subjectively under-represented mostly because of the timing of the season for whale sharks and the start of contributions from that area not aligning with the cut-off points for this report. The 2019 report is expected to show dramatically more from this remarkable region!

This map represents the sightings locations of the new sharks on the MWSRP database in 2018.

Once again, the MWSRP would like to take a moment to thank those BFN contributors for such valuable contributions to our understanding of this species in the Maldives.





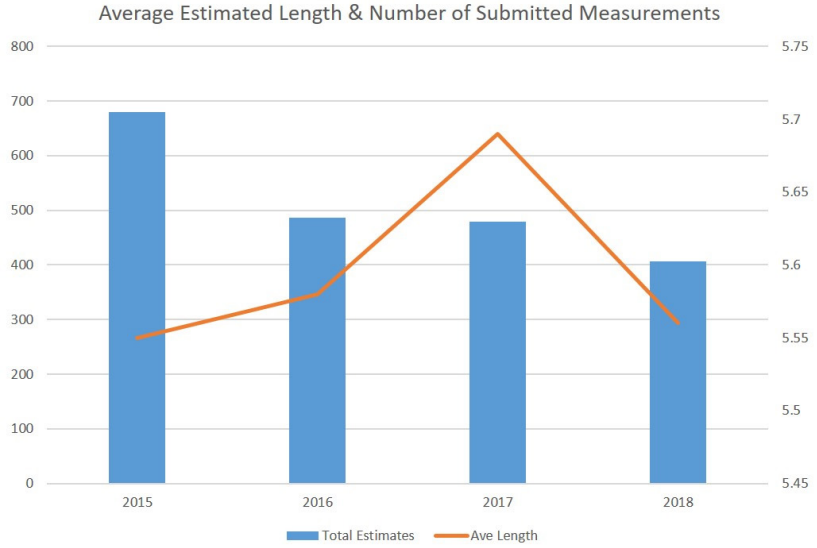
A question of size

As can be seen by the graph below, this year's average whale shark length of 5.56m from all 406 submitted estimations in 2018 (BFN & MWSRP) is remarkably consistent with previous years. There are a few possible explanations for this. Firstly, with around 97% of encounters coming from regions where the immature male demographic dominates, then it is likely an accurate reflection of the average size in these areas, with the very small or very large sharks just not having enough numbers to really sway the averages as yet. Secondly, with the mobile app and shark profiles now widely available, there the possible conscious or subconscious bias of contributors who know the individual shark they have seen and the exact measured length at the last encounter.

Where there does appear to be variance however is between stakeholders contributing. The MWSRP contributed 159 estimations on length, with 5.61m being the average from these, exclusively in SAMPA. Smallest shark MWSRP recorded was estimated 3.5m, with the next smallest being estimated at 4m and measured at 4.2m (WS382) and the largest 7m. The latter was later accurately measured at 7.4m (WS111).

The MWSRP conducts pre-training on actual objects of known size with all team members and volunteers in an effort to mitigate the inherent error in estimated sizes. This has proven to be valuable in 2018 with much less variability within shark estimated sizes. For example, the most frequently recorded shark of 2018, WS337 Shaiban, was recorded between 4.5 and 6m by volunteers during the last 12 months. Estimated lengths of this same individual submitted by contributors over the same period varied more drastically, between 3 and 7m submitted within 3 months of each other. He may have grown a bit, but he's a whale shark, not bamboo! So going forward, MWSRP will be including size estimation in all stakeholder training sessions and encourages stakeholders to do some simple practice of having objects of known size in the water and refining their size estimations on those.

Average length as estimated by BFN contributors over 2018 was 5.36m. Again, the majority of encounter submissions come from South Ari atoll, Baa or Thaa atoll, where the juvenile male demographic dominates, so this is in line with MWSRP's measured actuals. However, there are also a lot of sightings from other locations and as a result, the range of sizes encountered varied much more widely than MWSRP's SAMPA ranges. The smallest was just 2m, with the largest being estimated at 11m. Interestingly, both these were confirmed as female and both from the southern atolls. Photo evidence provided with the encounters suggested these estimations weren't unrealistic. Once more then the question is raised; what's going on with whale sharks in these areas?!



Here come the girls!

For the first time since MWSRP has been keeping records there were more newly identified female sharks than male sharks.

For the first time since the MWSRP has been keeping records, there were more newly identified female whale sharks than male ones in 2018. Of those whale sharks newly identified in 2018, 14 were female, 10 male and 13 unknown.

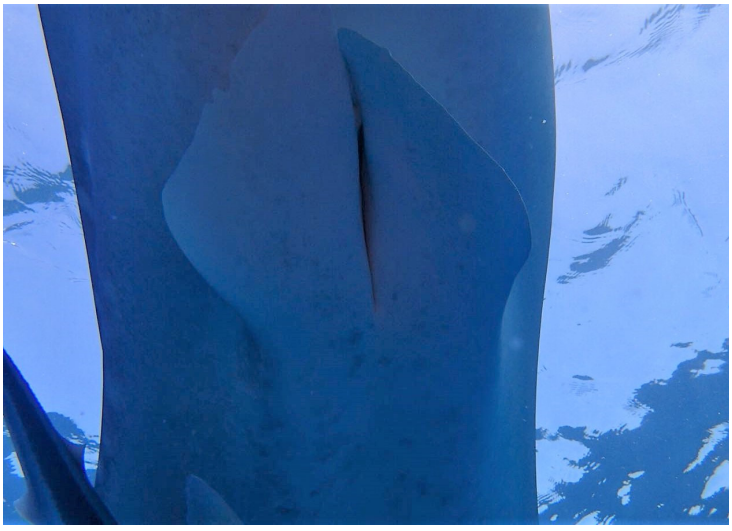
A key region driving this increase in female whale sharks is Fuvahmulah island. MWSRP would like to thank our friends from this area for their dedicated submissions to BFN and look forward to working with them going forward!

The breakdown for all whale sharks encountered in the 2018 (so both new and previously known sharks) was 54 male, 16 female and 15 where the sex was unknown. Still a male dominated bias of 77.1% where sex is known, but down on last year's 91.4% and as the BFN spreads and the search effort and data contributions from different regions begin to become more equal, then it will be fascinating to see how this bias changes (or not!) over time.

Taking a look at the overall database of 391 sharks on record as of the 1st February 2019, the sex breakdown now stands as; 50 females, 217 males and 124 unknown. Removing the sex unknown sharks and taking only that data where the sex has been positively identified, that results in a sex bias of 81.3% male. Last year this was 85.5%, itself a little over a percentage point on the year before. This continues the now growing comprehension that the usage of the Maldives by this species is likely a lot more variable than the typical coastal aggregations and what MWSRP had previously believed.

As was the case last season, there were a very large number of submissions to the BFN where sex was not recorded. In 121 submissions of 50 positively identified individuals (and 35 encounters where ID was unknown) sex was marked by a contributor as 'unknown'. However, of these identified sharks, 34 have known sex on record. Clearly this suggests that in the instances where no sex was recorded the contributor was simply unable to confirm the sex on that particular encounter. The MWSRP will be working with the software programmers behind the portal to develop an automated sex allocation on positively ID'd sharks in future to inform contributors at point of submission, reduce the number of sex non-allocated records in the database and mitigate erroneous sex allocations which later cause data handling challenges. As a temporary step, BFN contributors are respectfully asked to check the sex of a shark they have successfully identified on the mobile app before submitting.

"This continues the now growing comprehension that the usage of the Maldives by this species is likely a lot more variable than the typical coastal aggregations and what MWSRP had previously believed."



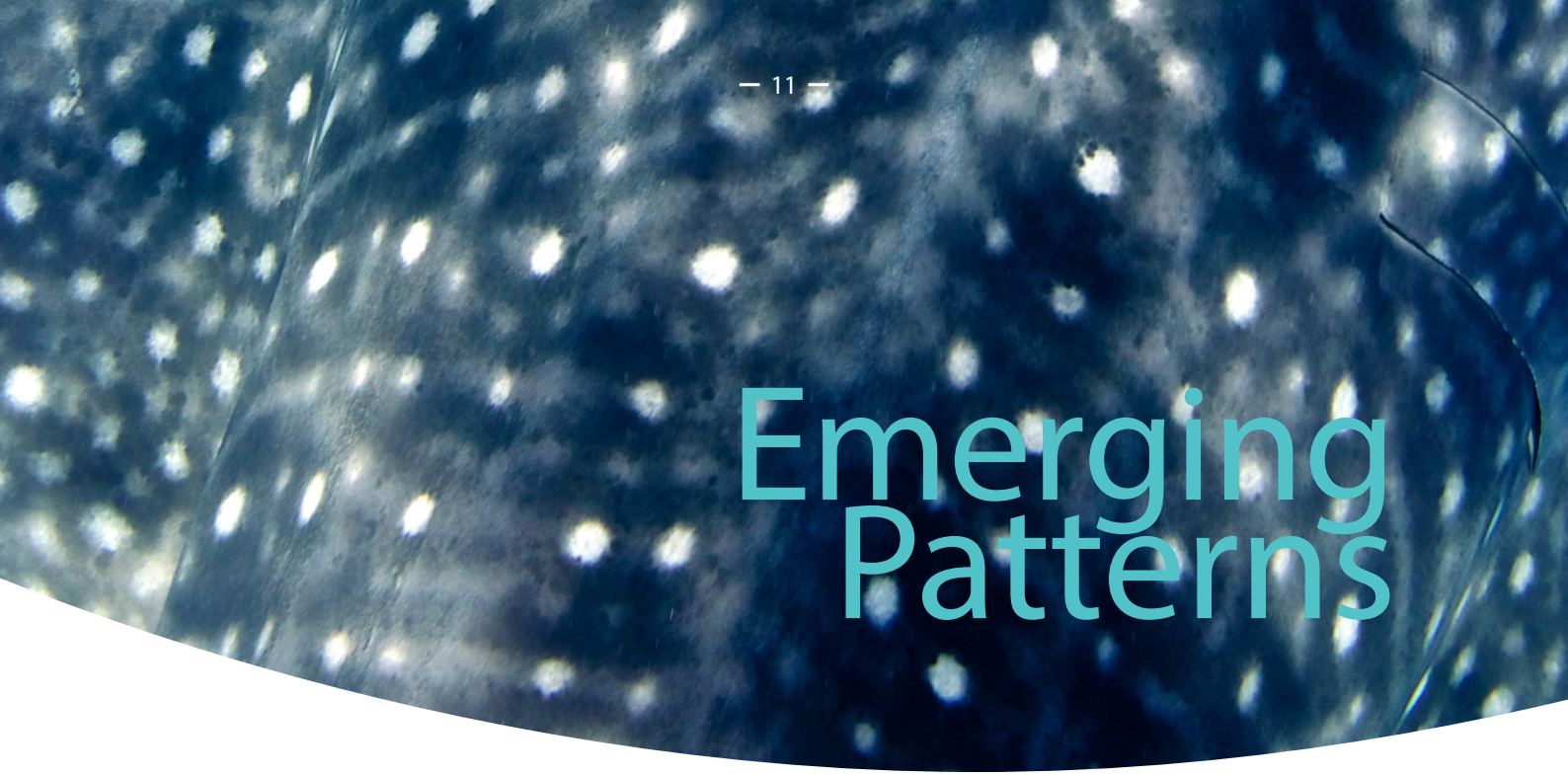
Do you come here often?

The title for the most frequently encountered individual whale shark over the 2018 went to WS337 'Shaiban' this year. Named after the grandson of our research vessels Captain. WS337 was encountered 60 times during the season, every time in South Ari atoll. WS337 was a new shark to the library at the end of 2017 – and basically hung around after! A little smaller than average, at 5.0m, he is regularly the only shark seen on a given day.

Second place is again WS221 'Igmale' (as he was last year) with 26. WS221 is a 6m male who's been around since 2014 but made a trip to Hanifaru Bay for the first time this year, before returning to SAMPA soon afterwards. WS262 'Radhun' is 3rd, with 25 sightings, with some in South Ari and some in Thaa again this year.

Those old stagers known to MWSRP for a decade or more, WS071 Fernando and WS108 Andy both showed up again, on 22 and 7 occasions respectively, all in SAMPA.

WS018 'Adam' marked his 12th year on record this year – an old friend from the very first trip MWSRP ever made to the Maldives in 2006!



Emerging Patterns

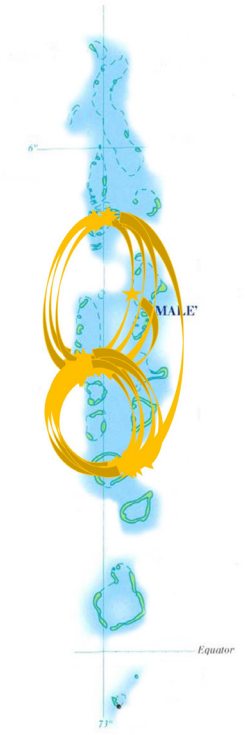
Inter-atoll movements by individual whale sharks

In 2017 MWSRP highlighted the seasonal movements of individual whale sharks between aggregation sites in the Maldives, as tracked by photo-identification mark re-capture from BFN contributors. For 2018, these records continued and an interesting mix of familiar faces making familiar moves was interlaced with other individuals seen outside of their principle aggregation site for the first time.

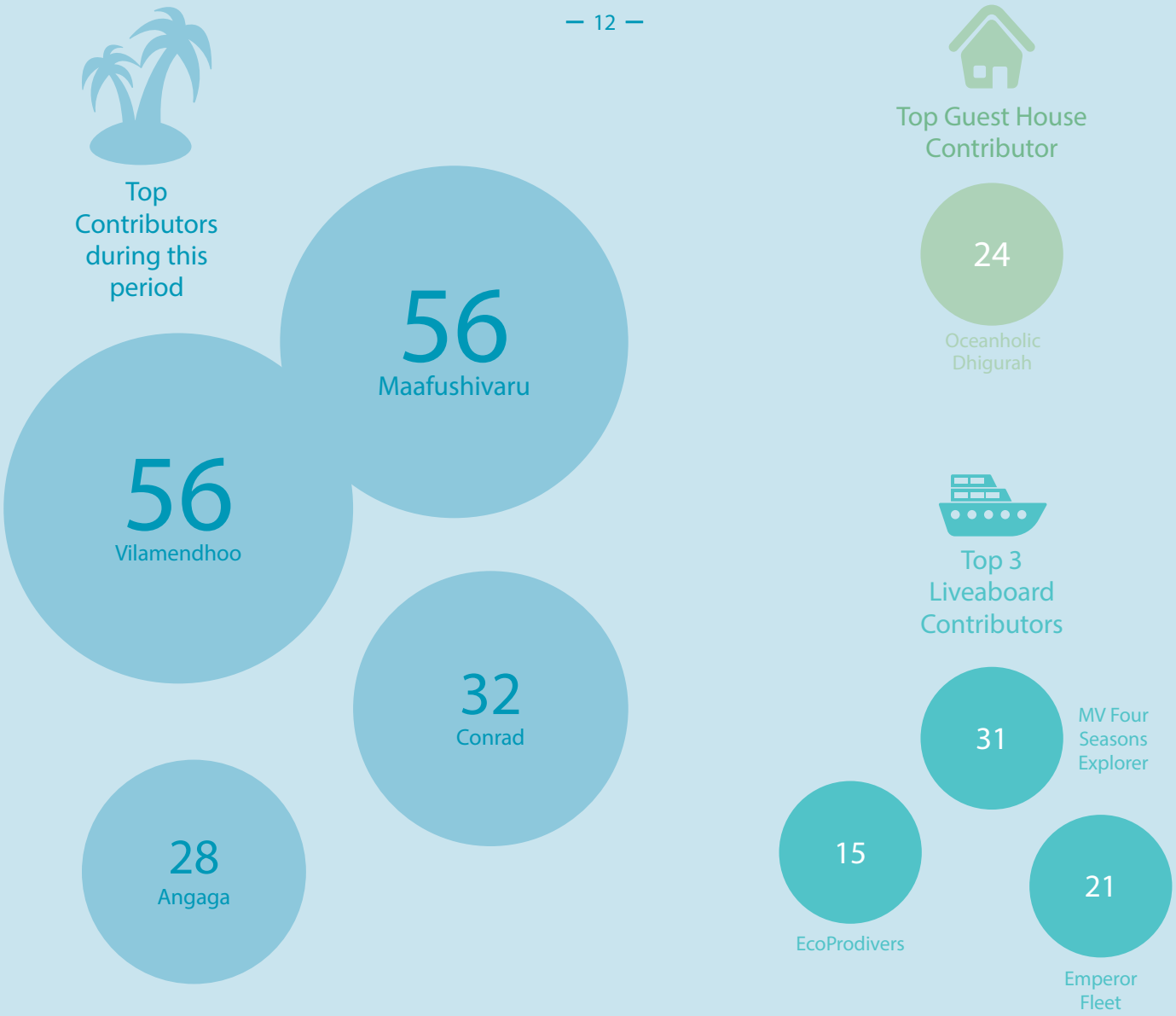
During the 2018 season, 11 different individuals made inter atoll movements. These can be viewed on this animation.

As before, individual whale sharks showed remarkable abilities to navigate with very high levels of spatial precision year after year in what appears to be learned behaviour. For example, WS014 'Raees', has been seen inside Hani Faru bay repeatedly and up to 9 years apart. This is of note because the entrance to the bay is only around 250m across and there is only one way in and out. In the BFN database there are 76 recorded sightings with 39 individuals within the immediate Hani Faru Bay vicinity. Of those, only 14 individuals have been seen more than once in the region. 8 of those have learned the trick of getting into the bay and have been seen in there repeatedly. WS014 was one of those sharks in there again last year!

It is known that the sharks do leave the Maldives and return as well as moving within the Maldives. Last year MWSRP and York MSc student Isabelle Eady collaborated to explore what it may be that drives these movements. Her abstract can be seen on page 14 and makes for interesting reading as well as pointing to other areas of research to explore more.



Map right: Overlapping all the movements between atolls individual whale sharks made in 2018 beautifully illustrates the connectivity between some of the major aggregation sites in the central atolls



Data Contributed by Big Fish Network Stakeholders

Where would MWSRP be today without the wonderful contributors to the BFN?! Submissions rose from 25 different tourism stakeholders in 2016 to 45 for this season, with a total of 358 direct encounters submitted! MWSRP were especially pleased to see 12 active safari vessel contributors, with the large and small sharks all being submitted by these adventurous floating hotels!

BFN members contributed data on 91 different sharks – out of the 97 different individuals encountered over the whole year! There was an additional 24 encounters submitted where the photograph could not allow for a positive identification or where an ID was missing completely.
As previously mentioned, the value of BFN contributors is often in identifying new individuals from areas outside of the MWSRP's operational area.

Honourable mention to Fuvahmulah Dive School for 6 all new and all female whale sharks!

The MWSRP is aware that taking photos and uploading data takes time. While we work to make it easier with our new 2 way app, we would like to take this opportunity to sincerely thank all contributors for their efforts in citizen science and hope that reading the results of their graft here inspires them to continue helping the cause!

Other Research

Peer Reviewed Outputs in 2018
Two peer reviewed papers were published in the 2018 season.

1

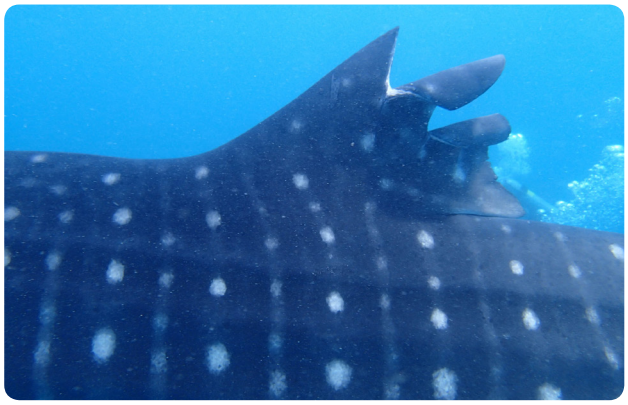
Journal Reference; Cameron T. Perry, Joana Figueiredo, Jeremy J. Vaudo, James Hancock, Richard Rees, Mahmood Shivji. Comparing length-measurement methods and estimating growth parameters of free-swimming whale sharks (Rhincodon typus) near the South Ari Atoll, Maldives. Marine and Freshwater Research, 2018; DOI: 10.1071/MF17393.

Abstract; Whale sharks (Rhincodon typus) are an endangered species whose growth and reproductive biology are poorly understood. Given their conservation concern, estimating growth parameters, as traditionally derived from vertebral samples of dead animals, is challenging. We used a non-invasive approach to investigate growth parameters of whale sharks frequenting the South Ari Atoll, Maldives by analyzing repeat measurements of free-swimming sharks over a 10-year period. Total lengths of the sharks were estimated by three measurement methods. Visual estimates underestimated the sizes of large sharks, while laser and tape measurements yielded similar results to one another. The Maldives aggregation consisted of primarily male (91%) juvenile (total length = 3.16 – 8.00 m) sharks and sharks new to the area were significantly smaller than returning sharks, which suggests that this site may constitute a secondary nursery ground. Estimates of von Bertalanffy (VBG) growth parameters for combined sexes (L = 19.6 m, k = 0.021 yr-1) were calculated from 186 encounters with 44 sharks. For males, VBG parameters (L = 18.1 m, k = 0.023 yr-1) were calculated from 177 encounters with 40 sharks and correspond to a male age at maturity of ~25 years and longevity of ~130 years. Differences between these estimates and those from other studies underscore the need for regional studies."

2

Journal Reference; Copping JP, Stewart BD, McClean CJ, Hancock J, Rees R. 2018. Does bathymetry drive coastal whale shark (Rhincodon typus) aggregations? PeerJ 6:e4904 https://doi.org/10.7717/peerj.4904

Abstract; The whale shark (Rhincodon typus) is known to aggregate in a number of coastal locations globally, however what causes these aggregations to form where they do is largely unknown. This study examines whether bathymetry is an important driver of coastal aggregation locations for R. typus through bathymetry's effect on primary productivity and prey availability. This is a global study taking into account all coastal areas within R. typus' range. R. typus aggregation locations were identified through an extensive literature review. Global bathymetric data were compared at R. typus aggregation locations and a large random selection of non-aggregation areas. Generalised linear models were used to assess which bathymetric characteristic had the biggest influence on aggregation presence. Aggregation sites were significantly shallower than non-aggregation sites and in closer proximity to deep water (the mesopelagic zone) by two orders of magnitude. Slope at aggregation sites was significantly steeper than non-aggregation sites. These three bathymetric variables were shown to have the biggest association with aggregation sites, with up to 88% of deviation explained by the GLMs. The three key bathymetric characteristics similar at the aggregation sites are known to induce upwelling events, increase primary productivity and consequently attract numerous other filter feeding species. The location of aggregation sites in these key areas can be attributed to this increased prey availability, thought to be the main reason R. typus aggregations occur, extensively outlined in the literature. The proximity of aggregations to shallow areas such as reefs could also be an important factor why whale sharks thermoregulate after deep dives to feed. These findings increase our understanding of whale shark behaviour and may help guide the identification and conservation of further aggregation sites."



Thesis Outputs in 2018

The MWSRP's third year of collaborations with the University of York's Environmental Science Masters Programme has again produced some high quality outputs, one of which is well on the way to publication. All of the below will be available in full on the MWSRP website once permission periods are finished. Should you wish for the full document, please contact MWSRP at info@maldiveswhalesharkresearch.org.

The Impacts of Anthropogenic Injury on Site Fidelity in Maldivian Whale Sharks (Rhincodon typus)

Abstract; "Whale sharks aggregate in predictable seasonal aggregations across the tropics. South Ari Atoll in the Maldives is one of a few year-round aggregation sites. Here boating traffic matches the whale shark hotspot, increasing the probability of anthropogenic injury. Whale sharks are reported to remain faithful to this aggregation site following injury, despite the costs of injury and the risk of re-injury. However, the impacts of injury on site fidelity and residency behaviour are not fully understood. Encounter data from the Maldives Whale Shark Research Programme were analysed to assess the impact of injury on site fidelity in whale sharks. There was no change in geographic site fidelity as a result of injury, but there were changes in residency timings. Injured resident whale sharks spent significantly longer at the atoll (+73 days ±8.6), less time absent from the atoll (-158 days ±23.0) and were seen more consistently (+2 residency periods ±0.3) than non-injured whale sharks. The residency duration, return rate and number of residency periods increased with increasing injury number and severity, whilst absence duration decreased. This implies a cost to injury, with whale sharks remaining in areas of high productivity to recover and spending less time in their pelagic phases. It highlights the importance of the South Ari Atoll aggregation, as these whale sharks do not leave, despite the risk of re-injury. This emphasises the need for the management of anthropogenic activities at aggregation hotspots, to reduce the injury rate and subsequent impacts on fitness."

Drivers of whale shark movements between atolls in the Maldives

Abstract; "The Maldives is home to a large number of whale sharks, Rhincodon typus. Much is known of the year round aggregation site in South Ari atoll, whose residents are protected by Marine Protected Area. Development of the citizen science network has enabled understandings of the distribution of the Maldives on a whole to be documented, and found that sharks are seen not only in Ari but across the island chains. However, movements in these areas are poorly understood. The aims of this therefore study were to identify sharks in other atolls, assess movement, and link this movement to environmental variables. The whale shark encounter data used in this database were collected by the Maldives Whale Shark Research Programme and citizen scientists spanning from 1992 to 2018. 13 environmental variables were modelled with sightings of moving sharks through subsets using Generalized Additive Models. 8 predictor variables were found to be significant, with 39.3% of variance explained by Oceanograhic variables atoll and distance to seamount while Temporal variables Time, month and year explained 21.1%. Indian Ocean Dipole Index, Sea Surface Temperature and chlorophyll-a combined accounted for only 2.85% of the variance. Whale sharks exhibited defined bi-annual movement between monsoons, and seasonal presence at all atolls other than South Ari. Seasonally alternating currents likely bring food resources distributed to different atolls that either become more or less suitable for whale sharks. Further research through satellite tagging is needed to confirm movements, and biomass samples carried out to quantify changes in prey species."

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whale sharks have been recorded making inter atoll movements

Best Behaviour

Other Ouputs

Part of the data the MWSRP records is the behaviour of the shark. The MWSRP assign each shark to one of five behavioural categories; 'Cruising', 'Evasive', 'Inquisitive' 'Interacting' and 'Feeding'. By recording these details, the MWSRP are able to compare against other factors – either environmental or human influenced – to see what affect they have on a shark.

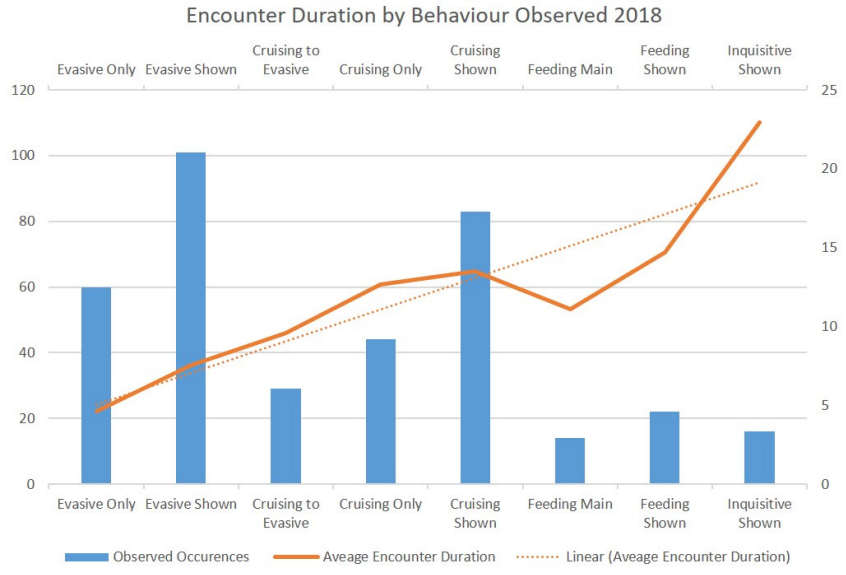
When relating behaviour to stress levels, 'Evasive' is considered the most stressed as sharks exhibiting an evasive response are likely to be being negatively influenced by a stimuli in their environment and are aiming to remove themselves from the negative stimuli as quickly as possible. The typical response is to dive into deeper water, this means that for human snorkellers visual contact is lost. 'Cruising' is not associated with stress in the sharks and is seen where the shark is not engaged in a particular activity, such as feeding or investigating unknown objects, but is not being impacted to the extent that it feels the need to avoid a stimuli. When sharks are 'Feeding', they are showing natural behaviour and are largely unresponsive to all but severe external stimuli. 'Inquisitive' sharks are actively engaged in approaching objects or humans in the water and are not considered to be under stress, as they do not look to remove themselves from the stimuli. 'Interacting' sharks exhibit a natural engagement with other sharks which are generally brief.

For the first time since MWSRP began recording behaviours of whale sharks at encounters in SAMPA, the primary behaviour recorded was not 'Cruising'. Unfortunately, from 167 observations of behaviour recorded, sharks exhibiting some 'Evasive' behaviour had become the most frequent (n=102).

While more work is needed to understand what could be driving any changes in behaviour, it is clear that the behaviour of the shark has an effect on the encounter durations. Evasive behaviour as the sole reaction was observed on 60 of the encounters, or 35.9%, for an average duration of just 4.64 minutes where visual contact was possible. Evasive behaviour of some description was recorded on 102 occasions overall. In this case average encounter duration increased to 7.56 minutes, though below the average encounter duration 9.7 minutes for the period. 'Cruising' sharks that were see to respond to a stimuli and react with evasive behaviour (n= 29), saw encounter time drop to 9.59 minutes whereas if the shark was undisturbed, those sharks only engaged in 'Cruising' had an average duration of 12.66 minutes over the 44 times it was recorded.

Sharks showing 'Feeding' in some capacity was recorded on 22 occasions for an average duration of 14.64 minutes. Where the shark showed some inquisitiveness, on 16 occasions, the duration went up to 22.93 mins on average.

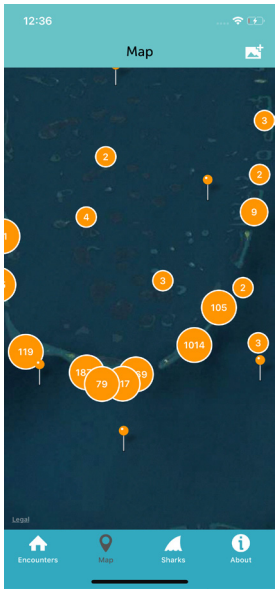
While a feeding, interacting or inquisitive shark may be difficult to predict, for a visitor wanting to make the most of their opportunity to swim with a whale shark, the message is clear; do not cause the shark stress and you will likely be rewarded with a longer encounter!

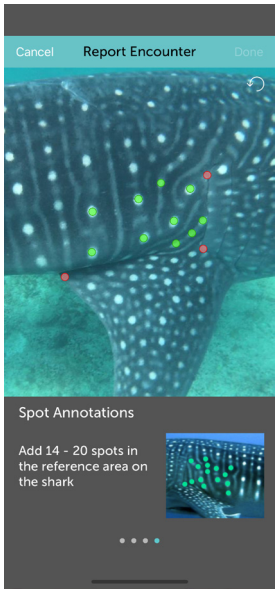


Whale Shark Network Maldives App. Version 2.0

From a data collection point of view, the big news of 2018 was the release of the Version 2.0 of the mobile app 'Whale Shark Network Maldives' on iOS.

The Version 2.0 had a critical functionality improvement which allows for two way data sharing. Anyone who has seen a whale shark can now not only ID that individual whale shark offline, but when their smart phone or tablet is back in internet range the app automatically sends the encounter data to the MWSRP, using metadata within the phone's picture tagging system to provide date, time and location. MWSRP see this app as being a transformative tool in reducing reasons for not sharing encounters and for improving citizen science benefits to the end user.





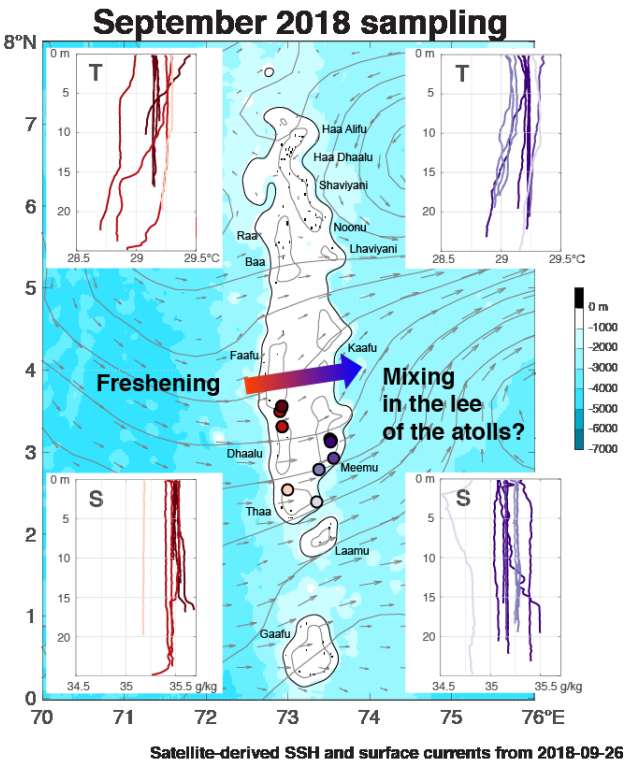
WSX2018 - Dedicated Liveaboard Charters

WSX2018 – Dedicated Liveaboard Charters

In 2018, MWSRP conducted three liveaboard cruises, including one dedicated charter as part of the Whale Shark Expedition, 'WSX' initiative. These were experimental expeditions conducted in partnership with Carpe with a principle aim to explore and collect data on the possible occurrence of whale sharks in the Maldives outside of the MWSRP's usual area of research. The secondary aim of the cruises was to collect data on other megafauna sightings in the central atolls related to seasonal movements and explore the physical environment around the atolls.

ID's were collected on 2 whale sharks and 23 manta rays over the three trips. Turtle sightings and ID's were also taken and shared with the Olive Ridley Project, with the Vaavu sightings proving useful as a population estimate tool from that area.

The MWSRP deployed a CTD device during the WSX trip, with the aim to understand more of the oceanographic processes around possible or known whale shark aggregation sites. This device measures Coductivity, Temperature and Depth, with conductivity relating to salinity. Initial results are highlighted in the figure below, showing that the water is consistently warm even by Maldives standards and that there is a clear freshening (decrease of salinity) from west to east. This may be at least partly due to the currents driving west to east causing turbulence and mixing as the water go over the atolls, which brings deep fresher water up. With whale sharks also being more prevalent on the eastern sides during the South West monsoon, this data is useful in posing questions which can be explored in WSX2019.



CTD data overlapped on a map showing the currents at the surface estimated from satellite. West side data is in red, east side is in purple. Temperature is plotted on the top panels, salinity on the bottom ones.

Megafauna surveys

2018 represented the seventh year that MWSRP has collected data on incidental megafauna sightings during the daily whale shark transect runs.

This year MWSRP added an additional 1395 records of marine megafauna, comprising 4080 individuals across all species to the overall database, which now runs to circa 8000 records!

Of course, recording data is what MWSRP does, but it's not to say that megafauna is simply noted and ignored. A chance to swim with a manta ray or watch dolphins play is an incredible opportunity in itself, so MWSRP are now focusing on getting more detailed and quality data on each megafauna encounter by investing a bit more time in these special sightings. This may mean stopping our search for whale sharks to get in with a manta ray and obtain a ventral ID photo, or spending time getting dorsal or scale pattern photos from cetaceans or turtles. This information is then shared with other NGO's operating in the Maldives who monitor and research these species. With Maldives NGO's invariably having limited time or space resources, mutual assistance by other organisations operating in an area where the dedicated charity does not have a presence is a valuable assistance – just look at the BFN for how MWSRP benefits!

In 2018, MWSRP contributed information on 61 different turtle encounters to the Olive Ridley Project (ORP), of which 27 were new to their individual ID database.

Other species of megafauna also tend to tell a wider story on the impact of humans on the ocean. Turtles which had drowned in netting, a humpback whale entangled in fishing ropes and dolphins missing dorsal fins have all been seen and all add to the growing understanding that care of the ocean and the creatures in it is something we must continue to invest efforts in.

For the fourth year in succession, the number of hawksbill turtles (Eretmochelys imbricata) recorded remained pretty stable with 605 sightings being recorded. Again, this made the hawksbill turtle the most frequently encountered species, by number of separate instances (NB; not necessarily individual turtles, we probably saw the same ones lots of times!).

Reef manta ray (Mobula alfredi) sightings were up again on last year, which itself was up on 2016. This season saw 56 encounters with for 109 individual rays, up on last years 49 encounters totalling 80 rays recorded. Surprisingly, this was not the most commonly encountered ray species, with stingrays having a bumper year and 88 encounters with 121 individual sting rays smashing last year's record of 17 encounters for 20 individuals!

The seemingly annual yoyo of Spinner dolphin (Stenella longirostris) sightings continued, with records of this species dropping again on last year, down from 69 encounters in which 1288 dolphins to just 36 encounters with 598 individuals. Conversely, Indo-Pacific bottlenose dolphin sightings were back up again, going from 67 encounters totalling 727 animals in 2017 to 116 encounters with 1961 individuals in 2018. Any cetacean biologists out there who could perhaps explain what may be going on!? Both species had an average pod size of 17, though there was a lot of variability in the bottlenose as over half of all records consisted of pods of 10 or less individuals, but on occasion up to 150 at a time were seen. Two mating events in bottlenose were also recorded, in November and December 2018.

Another remarkable increase in sightings was for sailfish, up from just 3 in 2017 to 57 records of 78 individual fish in 2018!

A full table detailing the number of each species sighted in the 2017 season can be seen below. If you are a marine biologist with an interest in one of the megafauna species listed in the table below; hit us up! The MWSRP would be happy to share the data with a good project!

Table

A full table detailing the number of each species sighted

Species	Number of Encounters	Number of Individuals
Hawksbill Turtle	605	613
Green Turtle	87	88
Olive Ridley Turtle	3	3
Marlin	7	7
Sailfish	57	78
Humpback whale	1	1
False Killer Whale	0	0
Short Fin Pilot Whale	3	46
Indo-Pacific Bottlenose Dolphin	116	1961
Risso's Dolphin	0	0
Spinner Dolphin	36	598
Eagle Ray	32	63
Reef Manta Ray	56	109
Mobula Rays Sp's	43	65
Oceanic Manta Ray	0	0
Stingray Sp's	88	121
Black Tip Reef Shark	12	12
Lemon Shark	0	0
Leopard Shark	2	2
White Tipped Reef Shark	0	0

Community Outreach Summary

"In the end, we will conserve only what we love; we will love only what we understand and we will understand only what we are taught." (Baba Dioum). To that, MWSRP would add that a big part of teaching is to actually see, feel and enjoy things first hand!

In 2017 the MWSRP launched the 'Moodhu Kudhin' or 'Children of the Sea' initiative. For 2018 the overarching concept of getting kids out of the classroom and into the wonderful teaching environment that is the ocean surrounding their homes continued to be a key goal and something that MWSRP team members love to do!

Actually, any school activities are always something MWSRP team members look forward to. Whether it is setting up a stall to talk about life as a marine researcher at a school Careers Day, handing out awards or prizes, giving presentations or helping supervise children in the water in the nationally promoted 'Farukoi' sessions, MWSRP was honoured to attend the different events with SAMPA schools during 2018.

We've said it time and again but the MWSRP is forever conscious of the effort it takes to find time and arrange things to join us in beach cleans, snorkels, school exchanges and other activities. We'd like to take this opportunity to sincerely thank the council members, school staff and other civic leaders and general good souls who help us, join in with us and welcome or host us on their islands! Shukuriyaa!

Getting out and about

The first group of children to get out on the water in 2018 were from Mandhoo school, the island where MWSRP was based before moving to Dhigurah in 2014. On 23rd February 2018 the team travelled to Mandhoo, where a series of presentations on whale sharks, marine megafauna and marine litter were given to the kids – and many of their parents too! The following day, decked out in live vests and assigned a in water guide per pair, the kids had a quick swim test and kit shakedown before heading offshore to see what they could see along the reefs of the western edge of South Ari atoll. They lucked out and had a great encounter with a manta ray, a species expected to be on that side of the atoll (with whale sharks!) during that time of year. After some impromptu learning about mantas, how to ID them and the work done by Manta Trust, the group returned to the island where a beach clean and a litter

workshop took place. This activity is done very regularly by MWSRP but consistently amazes participants when they try to visualise just how long everyday items take to break down and the potential for harm they have in the marine environment.

On the 10th & 11th August 2018 the MWSRP's island neighbour Dhangethi welcomed the team for a Moodhu Kudhin event. On this occasion, because of the size of the group, the kids were split into two. Half went onto the reef while the other half did the litter workshop, before swapping after lunch. The kids got super lucky – multiple manta rays in the lagoon of their island no less, and bottlenose dolphins out on the reef. Not a bad field trip! MWSRP were thrilled to be invited back to the island a few days later for the presentation of participation certificates, joined at the event by the Manta Trust and representatives from Vilamendhoo resort who were also doing other projects with the island school.

Back on Dhigurah on the 18th October 2018, the students of grades 7-9 joined MWSRP and a visiting international school to do an experiment to explore and document the seagrass beds on the eastern side of the island. With seagrass being such a vital habitat for juvenile reef fish and a natural stabiliser of the sand that makes the islands, understanding its health is important. The MWSRP will be looking to do annual monitoring effort in this area each year going forward, using the 2018 data the students collected as a baseline. After the time out in the lagoon looking at seagrass, the students collaborated on a beach clean, again supplemented by an information session on what had been found and the challenges it causes to the natural environment.

Beach cleans

Community beach clean events have always been common place, but with the increasing number of guesthouses on the local islands it was noticeable in 2018 the increase in the number of collaborative beach cleans being done. This is fantastic news as aside from any aesthetic value, it clears the debris which can harm wildlife on the land but also prevents plastics going back into the ocean where they can break down into microplastics or otherwise cause direct entanglement harm.

The MWSRP ran four independent beach cleans in the last year, as well as joining in other cleans or doing them for events such as Moodhu Kudhin. These cleans may be hot, sweaty, sandy and uncomfortable activities but they never cease to feel fulfilling. It is however unfortunate that these cleans are still needed and that such a volume of waste continues to wash up on the shores of islands. With the volume of tourism increasing, it is fortunate that the tourism industry is continuously improving its waste management. Going forward, the 'green wave' and increased awareness of the harm ocean debris does will no doubt continue to fuel determined further improvements. Hopefully one day the team will just be clearing up coconut leaves again!

Paid Maldivian Internship Scheme

In early January 2019 MWSRP secured a funding commitment from the start up clothing company 'In Sharks We Trust' for another three month internship, which will begin in June 2019.

The Maldives is blessed with a massive amount of people working in the dive and recreation industry who are immensely knowledgeable about the marine environment. This industry fuels a lot of employment for people with a love of the underwater world. But the concept behind the internship with MWSRP is to provide an opportunity for someone passionate and enthusiastic about starting in the world of marine sciences, but who is perhaps in another role outside of this specialisation or who has yet to start their first ever job and to whom exploring this new career possibility would not be viable without financial reassurance to cover living costs.

An MWSRP internship is seen as a springboard. It provides an opportunity to learn and be seen, but also offers a great chance to meet the small network of organisations and individuals in the marine sciences in the country. MWSRP make every effort to ensure that interns have an opportunity going forward and are extremely proud that at the time of writing the entire field team are ex-interns themselves!

Stakeholder Outreach Summary

The MWSRP has over a decade of time with the whale sharks and megafauna in South Ari atoll collecting records, watching change and pooling data from multiple stakeholders in the area. We are therefore always happy to meet with other stakeholders and share what has been gleaned or to present on the science behind things like the importance of best practice guidelines to those tourists who are lucky enough to be going to look for whale sharks!

Many of the safari vessels which embark on whale shark watching excursions will overnight near the MPA. The MWSRP is regularly invited out to these vessels to brief the guest on the biology and ecology of whale sharks in SAMPA and the Maldives and outline the government developed code of conduct for whale shark viewing excursions to the guests, explaining why these help to mitigate impact. Guests briefed in this way and with this information fresh in their minds for their time in the water make it was easier for the safari divemasters to reinforce the message too.

One of the activities that the MWSRP team are asked to do by stakeholders is to assist in providing an outsider's look at the whale shark excursions protocols in place at resorts or guesthouses. One such visit was to Diamonds resorts, who invited MWSRP to visit their resorts of Athuruga and Thundufushi in February 2018, where the team met with management, water sports representatives and marine biologists at the properties to share ideas and knowledge. The MWSRP also introduced some of the most up to date understandings on whale sharks in the region and the Big Fish Network, providing the training needed to identify individual sharks and submit whale shark encounter information, as well as the materials for promoting their work as contributors to their guests.

One of the bigger events of the year in SAMPA was the Lux* Underwater Festival between 16th and 22nd September 2018. MWSRP were privileged to attend and present at the event, which provided a great opportunity to network and also share knowledge with a wide audience because of the international nature of the attendees and the press present.

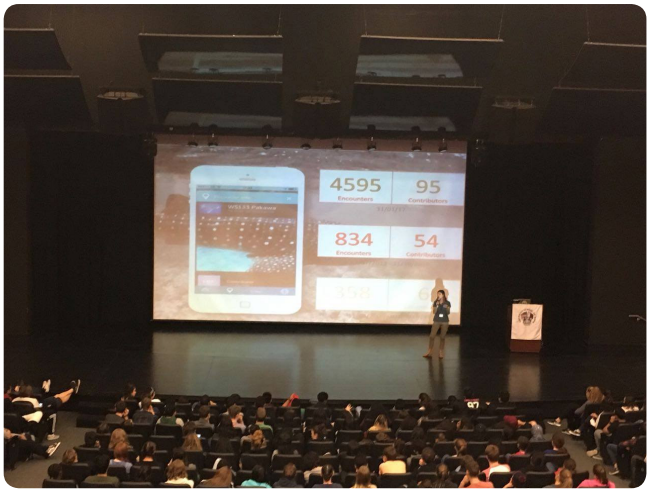
In total, MWSRP was invited to visit a safari vessel or resort on 27 occasions in 2018. We really appreciate the opportunities to share our knowledge and would like to thank all those stakeholders who welcomed us last year!

National Conferences

2018 was the year of the biannual Maldives Marine Sciences Symposium, held on the 24th July 2018. This is the largest gathering of marine scientists in the Maldives, with a full day of presentations providing a snapshot of the work ongoing across the country. The marine science community in the Maldives is relatively small, but due to the geographic lay out of the country they tend to be isolated and relatively independent for the majority of the year. These events represent a good opportunity for the groups to get together, network and share information and take new knowledge back to their respective islands.

MWSRP was represented by Basith Mohamed, who presented on the measurement methods, growth rates and age estimations work published earlier in the year.

It was also Basith who fronted at the Dhiraagu Maldives Road Race on Hulhumale, where he set up a stall to provide information to interested members of the crowd.



Big Fish Network updates and user additions

There are now 103 wonderful people or places that contribute their sightings information to MWSRP. Some of these are not quite so active, some are very active! Here we take a minute to salute the top contributors from each area;

The top three resort (and overall!) contributors during this period were;

Vilamendhoo (tied with 56)

1) Maafushivaru (tied with 56)

Conrad Maldives (32)

Angaga (28)

(Clap, clap, clap, clap!)

Top 3 Liveaboard Contributors were;

MV Four Seasons Explorer (31)

Emperor Fleet (21)

EcoProDivers (15)

(Clap, clap, clap, clap!)

Top Guest House Contributor

Oceanoholic (White Sands Dhigurah) (with 24)

*(Honourable mention to Fuvahmulah Dive School for 6 all new and all female sharks!)

(Clap, clap, clap, clap!)

This short section in no way reflects the debt of gratitude MWSRP holds to you good people of the BFN. We will be in contact through the year to work on what else we can do for you. We hope our thanks ringing in your ears does til then!

Television and Other Media Outputs

- The MWSRP appeared in print, on the radio and on the screen in the last 12 months as part of the teams efforts to showcase the Maldives, the SAMPA region and the whale sharks. Awareness is a key driver of action, with the focus on doing a small part to bringing this species and the threats it faces at a global scale into focus. Some of the highlights of the year are;
- Apple Inc featured MWSRP and the SAMPA region as part of their #ShotoniPhone campaign. Directed by Sven Dreesbach and Produced by Julia Etzelmuellerin, with Sven and Carlos Vargas doing the filming over the course of a month in field with MWSRP, the final documentary, called 'The Reef' can be viewed on YouTube (https://www.youtube.com/watch?v=8Ag_zvVl9RM) and artfully highlights the Programmes work and the novel use of app technology to enhance understanding on whale sharks in the Maldives
- In August, Pinky Productions, led by Josephine Robinson and with filming conducted by Danny Copeland and Chris Scarffe joined the MWSRP to film in the Maldives. The production team plan big things, with a desire to create a global 'best practice' video on how to swim with whale sharks. The time in the Maldives was the inaugural on location shoot, with the hopes to visit other aggregation sites in 2019 and 2020 for this global initiative.
- An article in Britain's Daily Mail magazine highlighted the work of the team and the plight of whale sharks globally https://www.dailymail.co.uk/travel/travel_news/article-6210109/The-magic-swimming-alongside-worlds-largest-fish-whale-shark-Maldives.html
- Field Team Leader Clara hosted two radio appearances to talk about threats to sharks worldwide and their conservation
- A beautiful short film by film maker Veerle Willems called 'Zain' was released. Named after grandson of the Captain of the MWSRP research vessel, the short follows young Zain's build up to his first encounter with a whale shark. A magical piece that showcases the beauty of the local islands perfectly. It can be viewed on Vimeo (https://vimeo.com/272775140)

Marine Life Rescues

Once again, 2018 bought in the sad sight of ghost nets and lost Fish Aggregation Devices (FADS) to the SAMPA region. These drift in from across the ocean before coming to a halt when they snag on the corals of the offshore reefs. Often times, they bring in with them entangled wildlife. Commonly this is the pelagic olive ridley turtles who may get tangled as they try to haul out to rest on the floating flotsam. The MWSRP team and volunteers encountered these entangled turtles on occasion during the whale shark transects. And this season it was not just turtles the team found entangled in these floating death traps.

On the 10th July 2018, the team were staggered to see a humpback whale at the surface, seemingly behaving in an unusual manner. It soon became clear that the individual was dragging a large ghost net entangled in its fluke. Despite the brave (and slightly foolhardy!) attempt by MWSRP member Basith Mohamed to cut it free, the whale ultimately disappeared with the net still in tow

Another ghost net, fortunately empty of marine life, was found and removed on the 7th August

The 22nd August saw two drifting FAD's removed in the same day

Another FAD was removed on the 15th October

The Olive Ridley Project, ORP, (http://oliveridleyproject.org/) operates a base in the Maldives as well as the only specialist turtle veterinarian in the country. They offer guidelines on what to do in the event that a net is encountered or if a turtle is entangled in it. Anyone finding ghost gear or an injured turtle in the Maldives is advised to contact the ORP, details for which are available on their website.

Plans for the Future

Research

With all the excitement of the nascent findings coming from 2018, the research questions posed for 2019 are for the most part either to build on or examine specific areas of wider findings.

Once again, the MWSRP will look to continue the important baseline observational research and apply this to studies that will contribute to the development of a MPA management plan in South Ari atoll.

MWSRP is also looking forward to WSX2019, with a safari vessel being chartered specifically to explore some more remote areas outside of our South Ari research area. Areas where there are whispers of other whale shark aggregations…!

Project titles for 2018 research questions

The following questions have been created to guide the 2019 research studies and outputs;

1. Are robust design or Bayesian modelling techniques stronger/ more reliable for analysing the whale shark population in South Ari atoll
2. An exploration of the oral history of whale sharks in the Maldives
3. Explore the feasibility of Electronic Monitoring as a tool for monitoring South Ari MPA.
4. Apply to SAMPA a review of the scientific basis of whale shark and other wildlife tourism guidlines

Continuation of observational research

We aim to increase understanding of;

a) The physical characteristics, distribution and behavioural ecology of whale sharks in the Maldives and

b) Further explore the significance of the primary aggregation site, South Ari atoll.

Significance of South Ari Marine Protected Area

The abundance of surface swimming whale sharks in South Ari might suggest the presence of a reliable food source. However the apparent lack of feeding behaviour exhibited by the individuals encountered near the surface has led MWSRP to hypothesise that the South Ari area may provide the optimum combination of habitats for these juvenile whale sharks. It is thought that the proximity of a deep water channel may offer opportunities for whale sharks to seek food at depth or facilitate long range movements, whilst also remaining in close proximity to a warm shallow water habitat for post-dive recuperation and thermoregulation. It is a key objective of the MWSRP to further understand why whale sharks are encountered in South Ari so consistently compared to other areas of the Maldives. We would like to establish what physical parameters make South Ari such an important aggregation site and which environmental conditions may affect the frequency of whale shark sightings in this area.

The MWSRP aims to:

- Continue to build a central register of whale shark individuals identified using photo-identification
- Keep an encounter log of observational data including shark characteristics, shark behaviour and environmental parameters
- Establish and maintain a national citizen-science monitoring network, through which tour operators from across the Maldives can submit encounter information and photographs via an online portal
- Identify key environmental and oceanographic parameters within the South Ari area
- Opportunistically collect whale shark faecal samples for genetic testing

Stakeholder and Community Outreach

2019 will see the appointment of former MWSRP Infield Coordinator Iru Zareer as a speciallist Outreach Officer. She will oversee the delivery of the community outreach in the form of Moodhu Kudin initiative and also our educational workshops. Iru will also laise with the industry and administer the Big Fish Network.

Education Toolkit

The MWSRP was approached to 'bring science to life' for Marine Science students in the Maldives. To develop a supplementary series of hands on, outdoor activities that complement and bolster the teaching beyond the syllabus.

To this end, MWSRP have joined forces with The Green Teen Team, Terra Mar Project, Blue Marine Foundation and an independent researcher to begin the creation of these activities. It is hoped that the first activities and trials will be undertaken in 2018.

Continuation of Internship & volunteer positions for Maldivian nationals

MWSRP will continue to offer annual opportunities for interns and volunteers. The selective intern positions focus on producing well trained and experienced individuals who stand the best possible chance of continuing in a career in the marine sciences or sustainable tourism sectors.

Local volunteer placements are intended as an opportunity to embark on an experience with minimal commitment so as to provide an accessible first look at work in the marine biology or sustainable tourism sectors. These positions are ideal for persons considering a move into these areas.

Engage the tourism industry through citizen science and stewardship initiatives

The aim of MWSRP to engage with excursion operators through training and awareness initiatives to try and minimise impacts of whale shark excursions. We aim to take a two pronged approach; firstly we want to inform the guests about the nature of the challenge and about the impacts they and the excursions they embark on are having on whale sharks. Secondly we will work to ensure that the resorts share and promote a standard, factual message. Ultimately it is hoped that it is the guests themselves who will drive the levels of expectations for an excursion which is safe and enjoyable, but also based on the expectation of self-regulation.

- The objective is to decrease tourist pressure on the whale shark in South Ari MPA through provision of standardised training and materials for whale shark tour operators and their guests whilst also encouraging greater citizen-science participation.

Acknowledgements

The MWSRP would like to sincerely thank the Marine Research Centre, the Environmental Protection Agency of Maldives and Adam Ziyad and his colleagues at the Ministry of Fisheries and Agriculture for their continued support of our work.
To the people and island councillors of Dhigurah and the islands of South Ari atoll and the South Ari atoll councillors, we appreciate so much you allowing us to spend time in your islands over these years and thank you for your hospitality and for sharing your wealth of knowledge with us.
Our Dhigurah island hosts TME Retreats Maldives for their logistical support, especially Fayaz Mansoor and Ilyas Mohamed
Dhigurah school principle Shifa and the students and other teachers – with special mention to Jackson – of Dhigurah school who so enthusiastically engage with our programme are offered special mention, we really appreciate you giving your time to work with us.
We also thank House Clover, Malè for providing essential logistical assistance throughout all of the trips, Amanda Onions of Hogan & Lovells and Bryan Kemsley for his in-kind accountancy service.
The volunteers of MWSRP, visiting teachers and school students who share their time and knowledge with us on the ground and who's donations allow us to continue our work we say a big 'shukuriyaa'!
And lastly one more big thank you to those contributors of the Big Fish Network for the knowledge you help to grow!

Tables and Figures

Tables

Table 1; Summary of the whale shark encounter information collected by MWSRP

From	May 2011	Nov 2011	May 2012	Oct 2012	Feb 2013	Feb 2014	Feb 2015	Feb 2016	Feb 2017	Feb 2018
To	May 2011	Feb 2012	June 2012	Feb 2013	Feb 2014	Feb 2015	Feb 2016	Feb 2017	Feb 2018	Feb 2019
No. of Whale Shark Encounters	6	171	51	155	352	308	319	365	306	175
No. of different Individual Sharks	4	36	20	33	44	50	45	49	43	35
Known Sharks	3	34	20	28	14	45	39	40	34	30
of which Male	3	32	19	28	13	40	35	47	32	30
of which Female	0	2	1	0	1	3	3	1	1	0
of which Sex Unknown	0	0	0	0	0	2	1	1	1	0
New Sharks	1	2	0	5	30	5	2	9	7	5
of which Male	1	0	0	5	26	4	1	8	4	5
of which Female	0	2	0	0	1	0	0	0	1	0
of which Sex Unknown	0	0	0	0	3	1	1	1	2	0
Average Shark Length (Metres)	4.5	6.08	5.64	5.58	5.82	5.92	6.2	5.46	6.11	5.61
Total Individual Whale Sharks in MWSRP Database	161	168	172	181	206	226	275	302	354	391

Table 2; Summary of the whale shark encounter information collected over the whole research period by members of the tourist sector

From	May 2011	Nov 2011	Mar 2012	May 2012	Jul 2012	Feb 2013	Feb 2014	Feb 2015	Feb 2016	Feb 2017	Feb 2018
To	Oct 2011	Feb 2012	Apr 2012	Jun 2012	Feb 2013	Feb 2014	Feb 2015	Feb 2016	Feb 2017	Feb 2018	Feb 2019
No. of Whale Shark Encounters	32	55	38	10	122	493	388	361	283	388	366
No. of Different Individual Sharks	24	25	23	7	33	U/Av	63	91	60	91	85
Known Sharks	19	25	19	6	27	U/Av	48	47	42	50	48
of which Male	17	23	18	5	26	U/Av	44	35	37	43	43
of which Female	2	2	1	1	1	U/Av	2	2	2	2	3
of which Sex Unknown	0	0	0	0	0	U/Av	2	10	3	5	2
New Sharks	5	0	4	1	7	U/Av	15	44	18	41	37
of which Male	5	0	3	1	7	U/Av	6	11	11	5	10
of which Female	0	0	1	0	0	U/Av	2	12	3	2	14
of which Sex Unknown	0	0	0	0	0	U/Av	7	21	4	34	13
Average Shark Length (Metres)	5.26	6.07	5.54	5.65	5.39	U/Av	5.17	5.59	5.71	5.53	5.36
Total Individual Whale Sharks in Database	161	168	172	173	181	206	226	275	302	354	391